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HP 75000 SERIES B and C

Eight-Channel Fixed Filter and Amplifier Signal Conditioning Plug-on HP E1509

User's Manual

The HP E1503 manual also applies to HP E1413Bs as HP E1413 Option 19.

Enclosed is the User's Manual for the HP E1509 Signal Conditioning Plug-on. Insert this manual in your HP E1413/E1313 manual behind the "Signal Conditioning Plug-ons" divider.

HEWLETT PACKARD

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HP E1509
Eight-Channel Fixed Filter and Amplifier Signal Conditioning Plug-on

Introduction

The HP E1509 is a Signal Conditioning Plug-on that provides eight fixed low-pass filters with a 3dB cutoff frequency of 7Hz and eight amplifiers with gain of 64. Also provided is input over-voltage protection and open transducer detection on each channel.

About this Manual

This manual shows you how to control the Signal Conditioning Plug-on (SCP) using SCPI commands as well as Register-Based commands, and explains the capabilities of this SCP. Finally, it covers specifications for this SCP. The contents of this manual are:

- Installation 3
- Identifying the Plug-on 3
- Connecting To The Terminal Module 4
- Programming With SCPI Commands 6
- Programming With Register Commands 8
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Installation

Installation for this Plug-on is common to several others and is covered in Chapters 1 and 2 of your HP E1413/E1313 manual.

Identifying the Plug-on

You'll find the HP part number on the connector side of the SCP to the left of the serial number bar code. For the HP E1509, the part number is : E1413-63519

Connecting To The Terminal Module

This section shows how to make connections to the Terminal Module.

The SCP connections for the Terminal Modules are shown on the stick-on labels that came with the SCP. Use the appropriate label for the type of Terminal Module you have. The connections and appropriate stickers are as follows:

- For HP E1413C and above Terminal Modules, use stickers for HP E1509 SCPs. The connections are shown in Figure 1.
- For HP E1313 Terminal Moduless, use stickers for HP E1509 SCPs. The connections are shown in Figures 2 and 3.
- For HP E1413B and below Terminal Modules, use stickers for HP E1413 Option 19 SCPs. The connections are shown in Figure 4.

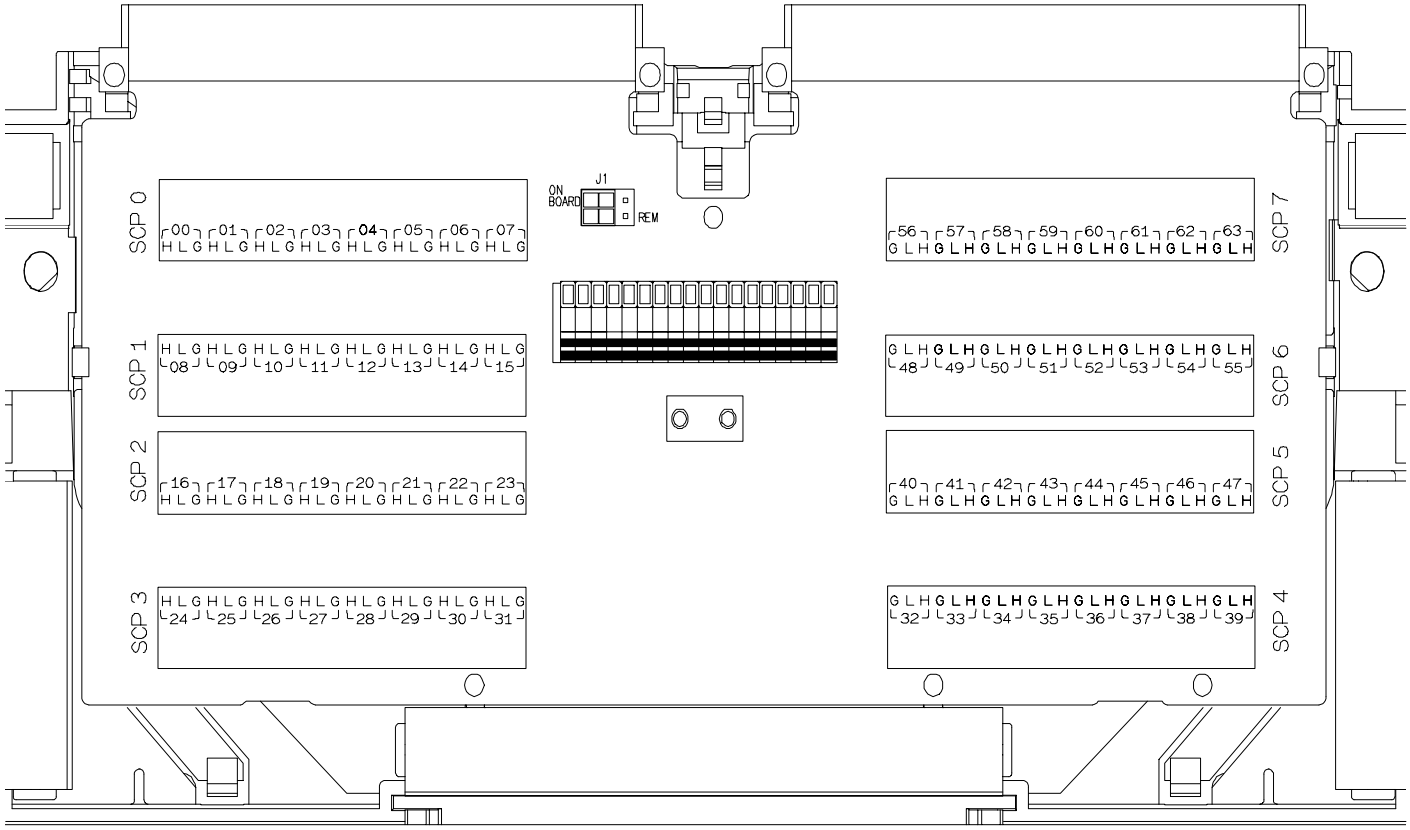


Figure 1 HP E1509 C-Size Terminal Module Connections

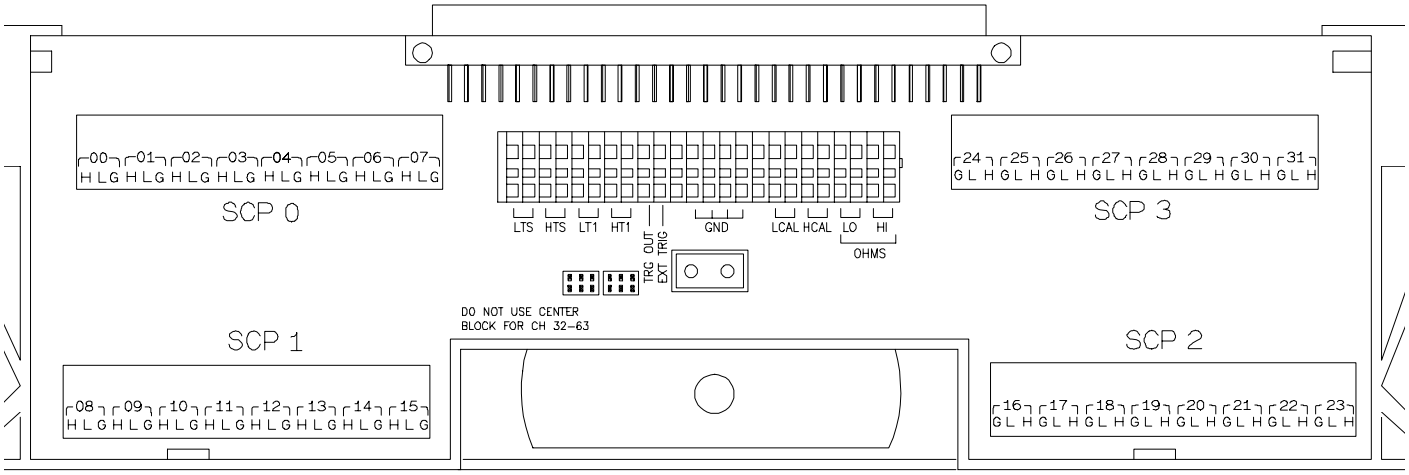


Figure 2 HP E1509 B-size Terminal Module Connections (Ch 00-31)

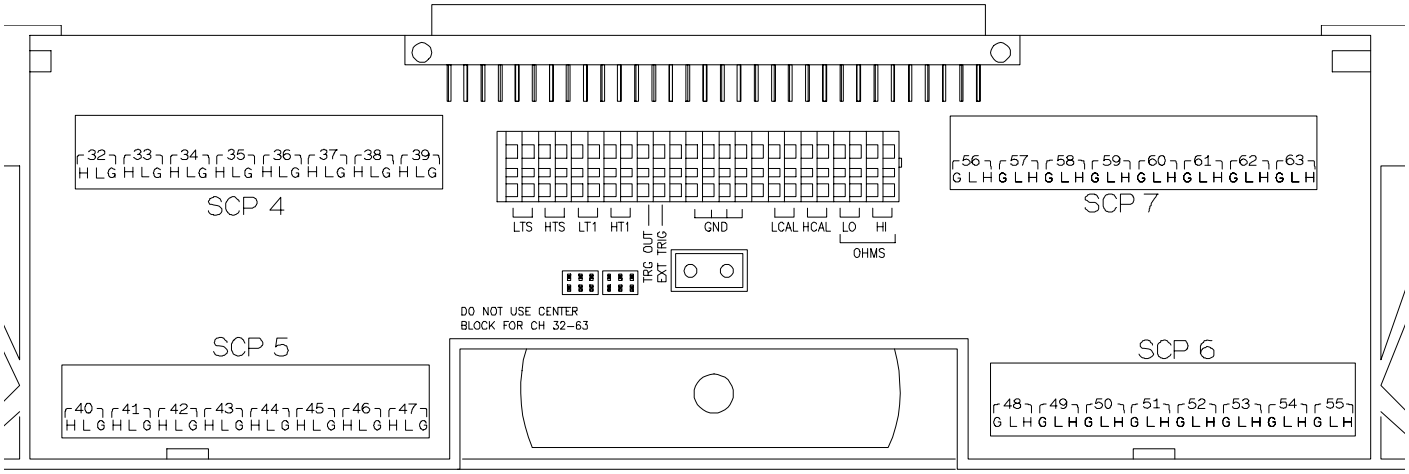


Figure 3 HP E1509 B-size Terminal Module Connections (Ch 32-63)

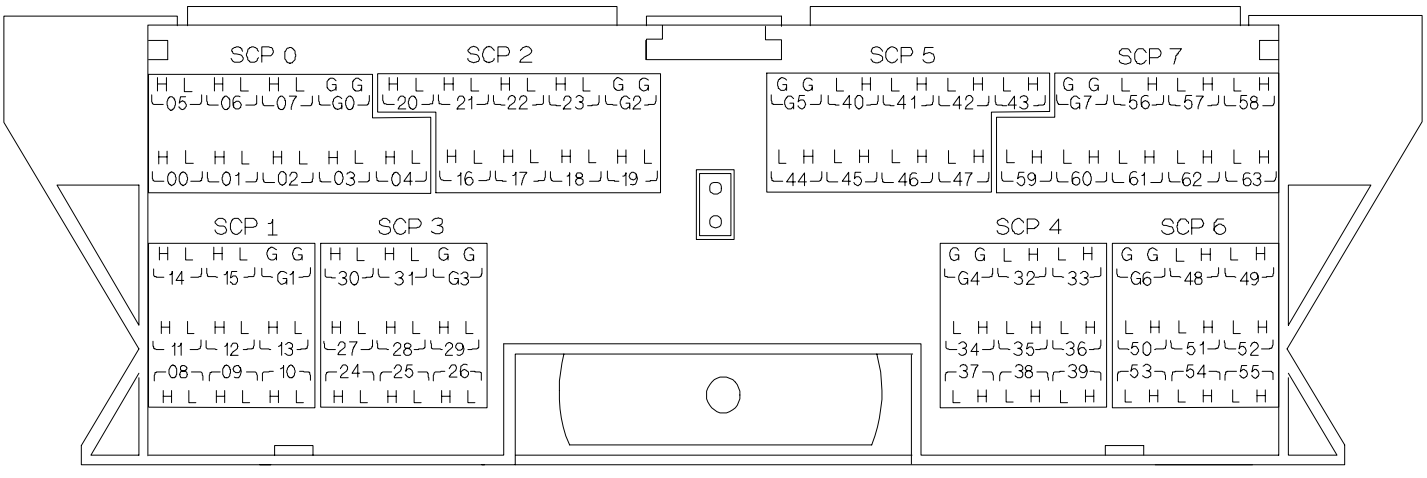


Figure 4 HP E1413 Option 19 Terminal Module Connections

Programming With SCPI Commands

The SCPI commands shown here are covered in Chapters 3 and 5 of your HP E1413/E1313 manual. This section will relate those commands to the parameter values which are specific to this Plug-on.

Checking the ID of the SCP

To verify the SCP type(s) installed on the HP E1413/E1313 use the SYSTem:CTYPe? (@<channel>) command.

- The *channel* parameter specifies a single channel in the channel range covered by the SCP of interest. The first channel number for each of the eight SCP positions are; 0,8,16,24,32,40,48, and 56.

The value returned for the SCP in an HP E1413B is:
HEWLETT-PACKARD,E1413 Opt 19 8-Channel Fixed Gain-Filter SCP,0,0

The value returned for the SCP in an HP E1313A/E1413C is:
HEWLETT-PACKARD,E1509 8-Channel Fixed Gain-Filter SCP,0,0

To determine the type of SCP installed on channels 0 through 7 send

```
SYST:CTYP?  (@100)                    query SCP type @ ch 0
enter statement here
```

Querying the Filter Cutoff Frequency

While the the HP E1509 does not provide programmable cutoff frequency the filter frequency can be queried. The response to this query will always be 7. To query any channel for its cutoff frequency use the INPut:FILTer[:LPASs]:FREQuency? (@<*channel*>) command. The INP:FILT:FREQ? command returns the numeric cutoff value currently set for the channel specified.

- The *channel* parameter must specify a single channel.

To query the cutoff frequency of channel 6 send

```
INP:FILT:FREQ?  (@106)                query channel 6
enter statement here
```

Querying the Filter State

While the HP E1509 does not allow controlling whether the filters are enabled or disabled, this state can be queried. The response to this query will always be 1. To query any channel to determine if it is enabled or disabled use the INPut:FILTer[:LPASs][:STATe]? (@<*channel*>) command. The INP:FILT? command returns a 0 if the channel is OFF or a 1 if the channel is ON.

- The *channel* parameter must specify a single channel.

To query the filter state of channel 2 send

```
INP:FILT?  (@102)                    query channel 2
enter statement here
```

Querying the Channel Gain

While the HP E1509's amplifiers have fixed gain, the channel gain can be queried. The response to this query will always be 64. To query any channel to determine its gain setting use the INPut:GAIN? (@<*channel*>) command. The INP:GAIN? command returns the current gain value for the specified channel.

- The channel parameter must specify a single channel.

To query the gain setting of channel 8 send

```
INP:GAIN?  (@108)                    query channel 8
enter statement here
```

Detecting Open Transducers

This SCP provides a method to detect open transducers. When Open Transducer Detect (OTD) is enabled, the SCP injects a small current into the HIGH and LOW input of each channel. The polarity of the current pulls the HIGH inputs toward +17 volts and the LOW inputs towards -17 volts. If a transducer is open, measuring that channel will return an over-voltage condition. OTD is available on a per SCP basic. all eight channels of an SCP are enabled or disabled together. See Figure 5 for a simplified schematic diagram of the OTD circuit.

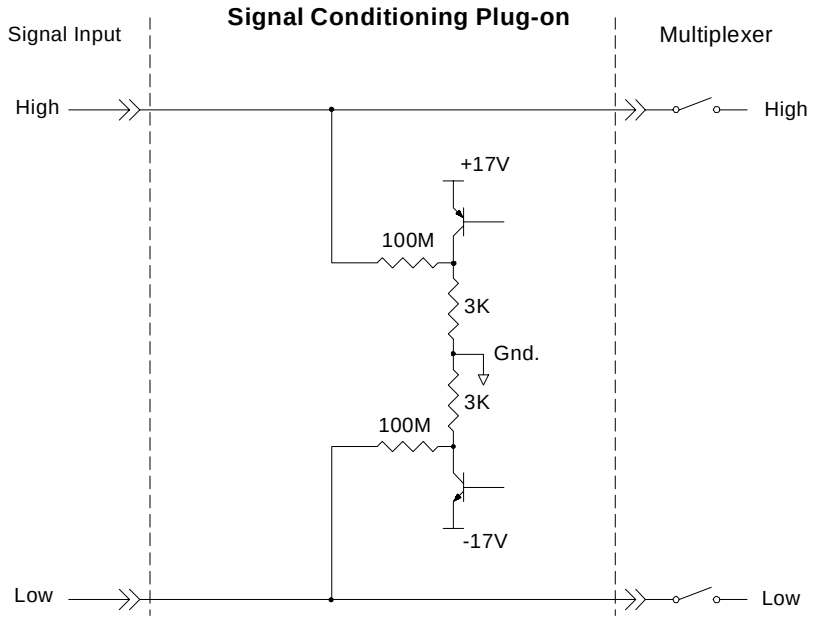


Figure 5 Open Transducer Detect Circuit

NOTES

1) When OTD is enabled, the inputs have up to 0.2µA injected into them. If this current will adversely affect your measurement, but you still want to check for open transducers, you can enable OTD, make a single scan, check the CVT for bad measurements, then disable OTD and make your regular measurement scans. The specifications apply only when OTD is off.

2) Allow 5 minutes before checking for open transducers to allow filter capacitors to charge.

To enable or disable Open Transducer Detection, use the DIAGnostic:OTDetect <*enable*>, (@<*ch_list*>) command.

- The *enable* parameter can specify ON or OFF
- An SCP is addressed when the *ch_list* parameter specifies a channel number contained on the SCP. The first channel on each SCP is:
  0, 8, 16, 24, 32, 40, 48, and 56

To enable Open Transducer Detection on all channels on SCPs 1 and 3:

```
DIAG:OTD ON, (@100,116)          0 is on SCP 1 and 16 is on SCP3
```

To disable Open Transducer Detection on all channels on SCPs 1 and 3:

```
DIAG:OTD OFF, (@100,116)
```

Register Based Programming

The register-based commands shown here are covered in Appendix D of the HP E1413/E1313 manual. You should read that section first to become familiar with accessing registers and executing Register-Based Commands. This section will relate those commands to the parameter values which are specific to this Plug-on.

When Register Programming an SCP most communication is through the Signal Conditioning Bus. For that you will use the Register Commands:

SCBWRITE <*regaddr*> <*regvalue*>
and
SCBREAD? <*regaddr*>

HP E1509 Register Map

Read (returned value)	Write(<*regvalue*>)	SCP Register	<*regaddr*> Value
SCP ID (9020_{16})		Whole SCP Reg 0	$00ppp000000_2$

ppp=Plug-on
ccc=SCP channel

In addition you will access bits in the Card Control register to control Open Transducer Detection.

Checking ID of SCP

To query an SCP for its ID value, write the following value to Parameter Register 1:

(*SCP number*) $\times 40_{16}$

Then write the opcode for SCBREAD? (0800_{16}) to the Command Register. The ID value will be returned to the Query Response Register.

Detecting Open Transducers

Open Transducer Detection (OTD) is controlled by bits in the Card Control Register. For more information on OTD see Figure 1.

Card Control Register (Base + 12_{16})

15	14	14-13	12	11	10-8	7-0
PSI Pwr Reset	FIFO Mode	unused	FIFO Clear	VPPEN	A24 Window	Open Transducer Detect

Writing a one (1) to a bit enables open transducer detect on that signal conditioning module. Writing a zero (0) to a bit disables open transducer detect.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
SCP 7	SCP 6	SCP 5	SCP 4	SCP 3	SCP 2	SCP 1	SCP 0

Specifications

These specifications for the HP E1509 reflect the combined performance of the HP E1413/E1313 and the HP E1509 Signal Conditioning Plug-on. These specifications are not to be added to those presented in the HP E1413/E1313 User's Manual.

General Specifications

Measurement ranges

DC Volts	±3.9mV to ±.25V FS
Temperature	Thermocouples - -200 to +1700 °C Thermistors - (Opt 15 required) -80 to +160 °C RTD's - (Opt 15 required) -200 to +850 °C
Resistance	(Opt 15 required) 128 ohms to 131 Kohms FS
Strain	25,000 με or limit of linear range of strain gage

Maximum input voltage
(Normal mode plus common mode)

Operating: < ±16 V peak Damage level: > ±42 V peak

Maximum common mode voltage

Operating: < ±16 V peak Damage level: > ±42 V peak

Normal mode rejection

@ 7Hz -3dB, @ 60Hz >-25dB

Common mode rejection

0-60Hz -100dB

Input impedance

100 Mohm ±10% (each differential input to ground)

Maximum tare cal offset

(Maximum tare offset depends on A/D range and SCP gain)

A/D range ±V F.Scale	16	4	1	0.25	0.0625
Max Offset	.04970	.01220	.00297	.00055	n/a

Measurement accuracy DC Volts

(90 days) 23°C ±1°C (with *CAL? done after 1 hr warm up and CAL:ZERO? within 5 min.). If autoranging is ON, add ±.02% FS to accuracy specifications. **For E1313, multiply Noise Spec. by 1.4.**

Gain 64

Range ±V FS	Linearity % of reading	Offset Error µV (10Hz)	Noise µV 3 sigma	Noise µV* 3 sigma
.0039	0.01	2.3	1.7	1.4
.0156	0.01	2.4	2.5	2.2
.0625	0.01	3.0	7.0	5.7
.25	0.01	8.0	28	23

* [SENSe:]FILTer[:LPASs][:STATe] ON (max scan rate - 100 rdgs/sec/channel)

Temperature Coefficients: Gain - 15ppm/°C. Offset - (0 - 30°C) .16µV/°C, (30 - 40°C) .18µV/°C, (40 - 55°C) .39µV

Measurement accuracy Temperature

(simplified specifications, see temperature accuracy graphs in HP E1413/E1313 manual for details)

(90 days) 23°C ±1°C (with *CAL? done after 1 hr warm up and CAL:ZERO? within 5 min.). If autoranging is ON, add ±.02% FS to accuracy specifications.

The temperature accuracy specifications include instrument and firmware linearization errors. The linearization algorithm used is based on the IPTS-68(78) standard transducer curves. Add your transducer accuracy to determine total measurement error.

Thermocouples

Type E

A/D Filter	-200 to 0 °C	0 to 200 °C	200 to 400 °C	400 to 800 °C
OFF	1.25°C	0.10°C	0.12°C	0.125°C
ON*	1.20°C	0.095°C	0.10°C	0.11°C

Type EEXtended

A/D Filter	-200 to 0 °C	0 to 200 °C	200 to 800 °C	800 to 1000 °C
OFF	13.4°C	0.30°C	0.20°C	0.35°C
ON*	13.3°C	0.25°C	0.15°C	0.30°C

Type J

A/D Filter	-200 to 0 °C	0 to 280 °C	280 to 600 °C	600 to 775 °C
OFF	1.50°C	0.10°C	0.15°C	0.17°C
ON*	1.47°C	0.11°C	0.15°C	0.15°C

Type K

A/D Filter	-200 to 0 °C	0 to 375 °C	375 to 800 °C	800 to 1400°C
OFF	2.25°C	0.15°C	0.20°C	0.25°C
ON*	2.70°C	0.15°C	0.17°C	0.25°C

Type R

A/D Filter	0 to 100 °C	100 to 200 °C	200 to 600 °C	600 to 1000 °C
OFF	1.40°C	0.75°C	0.45°C	0.30°C
ON*	1.40°C	0.70°C	0.40°C	0.30°C

* [SENSe:]FILTer[:LPASs][:STATe] ON (max scan rate - 100 rdgs/sec/channel)

Measurement accuracy Temperature (cont.)

(simplified specifications, see temperature accuracy graphs in HP E1413/E1313 manual for details)

Thermocouples (cont.)

Type S

A/D Filter	0 to 100 °C	100 to 200 °C	200 to 800 °C	800 to 1750 °C
OFF	2.85°C	1.35°C	0.70°C	0.65°C
ON*	2.85°C	1.80°C	0.65°C	0.55°C

Type T

A/D Filter	-200 to -100°C	-100 to 0 °C	0 to 200 °C	200 to 400 °C
OFF	1.35°C	0.25°C	0.10°C	0.15°C
ON*	1.35°C	0.22°C	0.10°C	0.13°C

5KΩ Reference Thermistor

A/D Filter	45 to 65 °C	65 to 85 °C
OFF	0.0061°C	0.011°C
ON*	0.0055°C	0.010°C

100Ω Reference RTD

A/D Filter	-125 to 70°C
OFF	0.080°C
ON*	0.080°C

100Ω RTD

A/D Filter	-200 to 75 °C	75 to 300 °C	300 to 600 °C	600 to 970 °C
OFF	0.08°C	0.21°C	0.27°C	0.37°C
ON*	0.07°C	0.18°C	0.25°C	0.35°C

2252Ω Thermistor

A/D Filter	63 to 70 °C	70 to 83 °C	83 to 100 °C
OFF	0.008°C	0.009°C	0.014°C
ON*	0.007°C	0.008°C	0.012°C

5KΩ Thermistor

A/D Filter	15 to 30 °C	30 to 70 °C	70 to 85 °C
OFF	0.011°C	0.013°C	0.017°C
ON*	0.010°C	0.013°C	0.017°C

10KΩ Thermistor

A/D Filter	30 to 60 °C	60 to 90 °C	90 to 115 °C
OFF	0.015°C	0.016°C	0.022°C
ON*	0.014°C	0.015°C	0.020°C

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